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MFN 09-244 Docket No. 52-010

April 17, 2009

U.S. Nuclear Regulatory Commission
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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 296 Related to ESBWR Design Certification Application – Electrical Power - RAI Number 8.3-62**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) responses to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAIs) sent by NRC letter No. 296, dated January 13, 2009 (Reference 1).

GEH response to RAIs 8.3-62 is provided in Enclosure 1. Enclosure 2 provides any affected DCD Sections.

Sincerely,

Richard E. Kingston

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Vice President, ESBWR Licensing

Reference:

1. MFN 09-052 - Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 296 Related To ESBWR Design Certification Application*, dated January 13, 2009

Enclosure:

1. MFN 09-244 -Response to Portion of NRC Request for Additional Information Letter No. 296 Related to ESBWR Design Certification Application – Electrical Power - RAI Number 8.3-62
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2. MFN 09-244 -Response to Portion of NRC Request for Additional Information Letter No. 296 Related to ESBWR Design Certification Application – Electrical Power - RAI Number 8.3-62 DCD Markups.

cc: AE Cubbage USNRC (with enclosure)
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EDRF Section 0000-0098-7391 (RAI 8.3-62)

MFN 09-244

Enclosure 1

Response to Portion of NRC Request for Additional

Information Letter No. 296 Related to ESBWR

Design Certification Application

Electrical Power

RAI Number 8.3-62

NRC RAI 8.3-62

The ESBWR DCD, Rev. 5, Section 8.3.2 lists the regulatory guides to which the application conforms. Among those regulatory guides , RG 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants", and RG 1.129, "Maintenance, Testing , and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants" are included. These two regulatory guides are related to vented lead-acid (VLA) batteries not to valve regulated lead acid (VRLA) batteries which are the batteries to be used in this design. Explain how these two standards are applicable to VRLA batteries.

GEH Response

GEH will revise the ESBWR DCD in Revision 6 to reflect a change to the safety-related batteries to Vented Lead Acid (VLA). Therefore, RG 1.128 and RG 1.129 that apply to "Large Lead Storage Batteries" and their endorsed IEEE standards are applicable to the ESBWR design. The attached DCD markups reflect the use of VLA batteries for ESBWR. Minor changes within Chapter 8 reflect the change back to the endorsed standards from the same RG 1.128 and RG 1.129 that have always been listed.

DCD Tier 2 Chapter 1 Tables 1.9-8, 1.9-21 and 1.9-22 were also reviewed for correction of the applicable regulatory guides, codes and standards. During this review, editorial errors in the Summary Description of Difference, Applicability Statement and typo (spelling) were found and included in the corrections found in the attached markups to the DCD. These corrections include RG 1.106, BTP ICSB 11, BTP ICSB 21 and a spelling correction at 1202-2006.

Per the phone discussion with the NRC, new COL Information item 8.3.4-1-A is added to provide the float and equalize voltages for the final safety-related battery selected. Also added, per the request of the NRC Staff, were notes 3) and 4) at Table 8.3-3 to clarify the added margin as discussed.
This RAI will also include the markups from the other affected Chapters 1, 16, and 16B.

For Chapters 16 and 16B, the Technical Specifications and Bases are revised to remove specific requirements added in DCD Revision 3 that were associated with adopting VRLA batteries and IEEE-1188. Other changes are made to more closely reflect BWR/6 Standard Technical Specifications (STS), NUREG-1434, Revision 3.1, considering changes to the BWR/6 STS that are proposed in Letter to NRC "Transmittal of TSTF-500, Revision 1, 'DC Electrical Rewrite - Update to TSTF-360'," dated November 5, 2008. The following discussion is provided to assist in supporting certain DCD changes and/or differences from these references, as well as addressing certain issues raised by the NRC Staff during a preliminary conference call held on March 5, 2008.

ESBWR DCD Section	NUREG-1434 Section	Discussion
- TS 3.8.1, Required Action A.2 Completion Time - TS 3.8.3, Required Action B.2 Completion Time	- TS 3.8.4, Required Action A.2 Completion Time - TS 3.8.6, Required Action B.2 Completion Time	In accordance with the NUREG-1434 Bases Reviewer's Note for this Action, the proposed ESBWR Completion Time is consistent with the exponential charging current portion of the battery charge profile following the service test, which is "24 hours" as specified in DCD 8.3.2.1.1.
TS 3.8.1 Action B Completion Time	TS 3.8.4 Actions B and C Completion Times	GEH Response to RAI 16.2-82 (MFN 07-023) addressed the differences in these Completion Times.
- SR 3.8.1.3 Note - SR 3.8.3.6 - COL-A Items 3.8.1-3 and 3.8.3-2	- SR 3.8.4.3, Note 1 - SR 3.8.6.6	Provisions to allow a "modified performance discharge test" to satisfy the required battery service test are removed from the DCD. As requested by NRC staff during a March 5, 2008 conference on this RAI, this provision should not be included -- not even if in brackets.
TS 5.5.10.a	TS 5.5.14.a and c	ESBWR had editorially combined these two requirements from the proposed changes in TSTF-500 since the actions were based on a single common condition of a low battery cell voltage.
Bases for SR 3.8.3.1	TSTF-500, Revision 1, Section 4.7.2, Commitment 1	The TSTF-500 commitment to maintain a design margin when utilizing float current as an indicator of battery charge, is captured in the ESBWR DCD Bases.
Bases for SR 3.8.3.2 and SR 3.8.3.5	TSTF-500, Revision 1, Section 4.7.2, Commitment 2	The TSTF-500 commitment to verify selection of the pilot cell after each quarterly surveillance is captured in the ESBWR DCD Bases.

DCD Impact

DCD Tier 2, 8.1.5.2.4, T8.1-1, 8.3.2.1.1, 8.3.2.1.2, 8.3.2.2.2, 8.3.4, 8.3.5, T8.3-4, T8.3-3, T1.9-8, T1.9-21, T1.9-22, and Chapter 16, Specifications 3.8.1 and 3.8.3 and 5.5.10 and Chapter 16B (Specifications 3.8.1 and 3.8.3).

MFN 09-244

Enclosure 2

Response to Portion of NRC Request for Additional

Information Letter No. 296 Related to ESBWR

Design Certification Application

Electrical Power

RAI 8.3-62 DCD Markups

Table 1.9-8

Summary of Differences from SRP Section 8

SRP Section	Specific SRP Acceptance Criteria	Summary Description of Difference	Subsection Where Discussed
8.1	GDC 2	None	
8.1	GDC 4	None	
8.1	GDC 5	The ESBWR is a single-unit plant. Therefore, this GDC is not applicable	8.1.5.2.4, Table 8.1-1, 8.2.2.2
8.1	GDC 17	None	
8.1	GDC 18	None	
8.1	GDC 50	None	
8.1	RG 1.6	The ESBWR does not need or have safety-related standby AC power sources.	8.1.5.2.4, 8.3.2 DC Power Systems
8.1	RG 1.9	The ESBWR diesel-generator units are not safety related, nor is AC power needed to achieve safe shutdown. Therefore, this RG is not applicable.	8.1.5.2.4, Table 8.1-1
8.1	RG 1.32	Safety-related DC power sources are provided to support passive core cooling and containment integrity safety functions. No offsite or diesel-generator-derived AC power is required for 72 hours.	8.3.2, 8.1.5.2.4, Table 8.1-1
8.1	RG 1.47	None	
8.1	RG 1.53	None	
8.1	RG 1.63	None	
8.1	RG 1.75	None	
8.1	RG 1.81	The ESBWR Standard Plant is designed as a single-unit plant. Therefore this RG is not applicable. (Same as GDC 5)	8.1.5.2.4, Table 8.1-1

Table 1.9-8

Summary of Differences from SRP Section 8

SRP Section	Specific SRP Acceptance Criteria	Summary Description of Difference	Subsection Where Discussed
8.1	RG 1.106	The ESBWR does not require 480 VAC electric motors or motor operated valves to perform any safety-related function, therefore, this regulatory guide is not applicable.~~None~~	8.1.5.2.4, Table 8.1-1
8.1	RG 1.118	None	
8.1	RG 1.128	None~~The ESBWR design allows for installation design and installation of batteries in accordance with IEEE 1187. IEEE 484 is not applicable for Valve-Regulated Lead-Acid (VRLA) batteries.~~	~~8.1.5.2.4, 8.3.2.2.2~~
8.1	RG 1.129	None~~The ESBWR design allows for periodic testing, maintenance, and replacement of batteries in accordance with IEEE 1188. IEEE 450 is not applicable for Valve-Regulated Lead-Acid (VRLA) batteries.~~	~~8.1.5.2.4, 8.3.2.2.2~~
8.1	RG 1.153	None	
8.1	RG 1.155	The ESBWR does not require AC power to achieve safe shutdown. Thus ESBWR meets the intent of RG 1.155.	15.5.5, Special Event Evaluations
8.1	RG 1.160	Maintenance Rule development is addressed in Chapter 17 and Subsection 13.5.2 for Operating and Maintenance Procedures.	8.1.5.2.4, 13.5.2, 17.4.9
8.1	BTP ICSB 4	Not BWR applicable (PWR)	N/A
8.1	BTP ICSB 8	The ESBWR can achieve safe shutdown without AC power, and the diesel-generator sets are not safety-related. Therefore this criterion is not applicable.	N/A

Table 1.9-8

Summary of Differences from SRP Section 8

SRP Section	Specific SRP Acceptance Criteria	Summary Description of Difference	Subsection Where Discussed
8.1	BTP ICSB 11	~~This is a COL licensing requirement~~See Subsection 8.2.2.1 for the analysis of the reliability and stability of the offsite transmission systems.	8.2.4~~.9~~, 8.1.5.2.4, 8.2.2.1
8.1	BTP ICSB 18	There are no safety-related, manually controlled, electrically operated valves in the ESBWR design. All safety-related valves are automatic and require no manual action for 72 hours. This BTP is not applicable to the ESBWR design.	8.1.5.2.4
8.1	BTP ICSB 21	None~~The offsite power system is nonsafety-related. Therefore, the BTP is not applicable to the ESBWR design.~~	~~8.2.2.2~~
8.1	BTP PSB 1	Degraded voltage in the offsite power system does not affect the safety-related systems, as the 480 VAC Isolation Power Centers do have degraded voltage protection.	8.1.5.2.4, 8.3.1.1.2
8.1	BTP PSB 2	This BTP does not apply because the diesel-generator sets do not serve a safety-related function.	8.1.5.2.4
8.1	NUREG/CR-0660	Not applicable, the ESBWR does not use safety-related diesels to achieve safe shutdown. However, defense-in-depth principles such as redundancy and diversity are incorporated in the design and integration of ESBWR systems.	8.1.5.2.4
8.1	NUREG-0718, Revision 1	Not applicable to the ESBWR. NUREG-0718 only applies to the pending applications as of February 16, 1982.	Table 8.1-1

Table 1.9-21

NRC Regulatory Guides Applicability to ESBWR

RG No.	Regulatory Guide Title	Appl. Rev.	Issued Date	ESBWR Appli-cable?	Comments
1.128	Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants	1	10/1978	Yes	~~See Table 1.9-8 for exception.~~
1.129	Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants	1	02/1978	Yes~~—~~	COL~~. See Table 1.9-8 for exception.~~
1.130	Service Limits and Loading Combinations for Class 1 Plate-and-Shell-Type Component Supports	1	10/1978	Yes	
1.131	Qualification Tests of Electric Cables, Field Splices, and Connections for Light-Water-Cooled Nuclear Power Plants	0	08/1977	Yes	See also proposed Rev 1 published 08/1979 as RS 050-2.
1.132	Site Investigations for Foundations of Nuclear Power Plants	2	10/2003	—	COL
1.133	Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors	1	05/1981	No	A loose-parts monitoring system is not included in the ESBWR design.
1.134	Medical Evaluation of Licensed Personnel at Nuclear Power Plants	3	03/1998	—	COL
1.135	Normal Water Level and Discharge at Nuclear Power Plants	0	09/1977	Yes	
1.136	Design Limits, Loading Combinations, Materials, Construction, and Testing of Concrete Containments	3	03/2007	Yes	

Table 1.9-22

Industrial Codes and Standards[2] Applicable to ESBWR

Code or Standard Number	Year	Title
323-1974	1974	Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations (Note – this earlier version is applied to RG 1.89 qualification of equipment in a harsh environment)
323-2003	2003	Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations
334-1994	1994 (R 1999)	IEEE Standard for Qualifying Continuous Duty Class 1E Motors for Nuclear Power Generating Stations (Note: 2006 version exists)
336-1985	1985 (R 1991)	Standard Installation, Inspection and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities
338-1987	1987 (R 2000)	Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems (Note: 2006 version exists)
344-1987	1987 (R 1993)	Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations (Note: 2004 version exists, but it is not endorsed by NRC.)
352-1987	1987 (R 2004)	Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Safety Systems (including errata dated 4 April 1994)
379-2000	2000	Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems
381-1977	1977 (R 1984)	Standard Criteria for Type Tests of Class 1E Modules Used in Nuclear Power Generating Stations
382-1996	1996 (R 2004)	Standard for Qualification of Actuators for Power-Operated Valve Assemblies with Safety-Related Functions for Nuclear Power Plants (Note: 2006 version exists)
383-2003	2003	Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations
384-1992	1992 (R 1998)	Standard Criteria for Independence of Class 1E Equipment and Circuits
420-2001	2001	Standard for the Design and Qualification of Class 1E Control Boards, Panels, and Racks Used in Nuclear Power Generating Stations
450-1975	1975	Recommended Practice for Maintenance, Testing, and Replacement of large Lead Storage Batteries for Generating Stations and Substations
484-1975	1975	Recommended Practice for Installation of Large Lead Storage Batteries for Generating Stations and Substations
485-1997	1997 (R 2003)	Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
497-2002	2002	Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations

Table 1.9-22

Industrial Codes and Standards[2] Applicable to ESBWR

Code or Standard Number	Year	Title
1042-1987	1987 (R 1993)	Guide to Software Configuration Management
1050-1996	1996	Guide for Instrumentation and Control Equipment Grounding in Generating Stations (Note: 2004 version exists but is not endorsed by RG 1.204)
1058-1998	1998	Standard for Software Project Management Plans
1058.1-1987	1987 (R 1993)	Standard for Software Project Management Plans
1074-1995	1995	Standard for Developing Software Life Cycle Processes (Note: 2006 and 1997 versions exist, but are not endorsed by NRC.)
1082-1997	1997 (R 2003)	Guide for Incorporating of Human Action Reliability Analysis for Nuclear Power Generating Stations
~~1187-2002~~	~~2002~~	~~IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications~~
~~1188-2005~~	~~2005~~	~~IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications~~
1202-2006	2006	Standard for Flame-Propagation Testing of Wire and Cable
1205-2000	2000	Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations
1219-1998	1998	IEEE Standard for Software Maintenance
1228-1994	1994 (R 2002)	Software Safety Plans
C2-2002	2002	National Electrical Safety Code (Note: 2007 version exists)
C37.04-1999	1999	Standard Rating Structure for AC High-Voltage Circuit Breakers (including Errata published 29 November 2005)
C37.04a-2003	2003	Amendment 1 – Capacitance Current Switching
C37.06-2000	2000	AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities – Replaces NEMA C37.06-2000 (Also endorsed by ANSI)
C37.09-1999	1999	Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
C37.010-1999	1999	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (Also endorsed by ANSI)
C37.11-1997	1997 (R 2003)	Standard Requirements for Electrical Control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Revision of ANSI C37.11-1979
C37.13-1990	1990 (R 1995)	Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
C37.013-1997	1997	IEEE Standard for AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current Basis

- GDC 17, "Electric Power Systems" - Safety-related DC power sources are provided to support passive core cooling and passive containment integrity safety-related functions. No offsite or diesel-generator-derived AC power is required for 72 hours after an abnormal event. However, the ESBWR standard design PPS complies with GDC 17 with respect to two independent and separate offsite power sources and standby onsite power sources, each with the capacity and capability to power equipment during design basis operating modes (plant start-up, normal operation, safe shutdown, accident, and post-accident operation). Subsection 3.1.2.8, "Criterion 17 – Electric Power Systems," provides ESBWR electric power source availability requirements and conformance with Regulatory Guide 1.93.
- GDC 18, "Inspection and Testing of Electric Power Systems" - Safety-related DC power sources are provided to support passive core cooling and passive containment integrity safety-related functions. No offsite or diesel-generator-derived AC power is required for 72 hours after an abnormal event. However, the nonsafety-related offsite and onsite AC systems that supply AC power to the Isolation Power Centers are testable and meet GDC 18 requirements.
- GDC 50, "Containment Design Basis"

NRC Regulatory Guides:

- Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems" – The ESBWR Standard Plant does not need or have safety-related standby AC power sources; however, portions pertaining to the safety-related DC system are addressed within Subsection 8.3.2. The ESBWR offsite and onsite nonsafety-related power sources do comply with independence and redundancy between their sources and distribution systems.
- Regulatory Guide 1.9, "Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants"– The ESBWR diesel-generator units are not safety-related, nor is AC power needed for the ESBWR to achieve safe shutdown, therefore this regulatory guide is not applicable to the ESBWR design.
- Regulatory Guide 1.32, "Criteria for Power Systems for Nuclear Power Plants." Safety-related DC power sources are provided to support passive core cooling and containment integrity safety functions. No offsite or diesel-generator-derived AC power is required for 72 hours after an abnormal event. IEEE 1188, not IEEE 450, is applicable to VRLA batteries.
- Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems."
- Regulatory Guide 1.53, "Application of the Single-Failure Criterion to Safety Systems."
- Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants."
- Regulatory Guide 1.75, "Criteria for Independence of Electrical Safety Systems." Safety-related equipment relies only upon DC-derived power and meets the design requirements for physical independence.

- Regulatory Guide 1.81, "Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants" – The ESBWR Standard Plant is designed as a single-unit plant. Therefore, Regulatory Guide 1.81 is not applicable.
- Regulatory Guide 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves." The ESBWR does not require 480 VAC electric motors or motor operated valves to perform any safety-related function, therefore, this regulatory guide is not applicable.
- Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems" (see Subsection 13.5.2 for Operating and Maintenance Procedures and Chapter 16 for Technical Specifications).
- Regulatory Guide 1.128, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants." ~~The ESBWR Valve Regulated Lead Acid (VRLA) batteries' recombination of hydrogen effectiveness is 99% while battery room temperature and charging voltage are within specified vendor limits during charging evolutions. IEEE 344, IEEE 323, IEEE 485, and IEEE 1187 apply to VRLA batteries. IEEE 484 is not applicable for VRLA batteries.~~
- Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants." ~~The ESBWR design allows for periodic testing, maintenance and replacement of batteries in accordance with IEEE 1188. IEEE 450 is not applicable for VRLA batteries.~~
- Regulatory Guide 1.153, "Criteria for Safety Systems."
- Regulatory Guide 1.155, "Station Blackout" – The ESBWR does not require AC power to achieve safe shutdown. Thus, the ESBWR meets the intent of Regulatory Guide 1.155. The Station Blackout evaluation is provided in Section 15.5.
- Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" - Maintenance Rule development is addressed in Table 1.9-21 and Subsection 13.5.2 for Operating and Maintenance Procedures.
- Regulatory Guide 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants" Refer to Subsection 8A.1.2.

Branch Technical Positions:

- BTP ICSB 4 (PSB), "Requirements on Motor-Operated Valves in the ECCS Accumulator Lines" – This BTP is written for pressurized water reactor (PWR) plants only and is therefore not applicable to the ESBWR.
- BTP ICSB 8 (PSB), "Use of Diesel-Generator Sets for Peaking" – The ESBWR can achieve safe shutdown without AC power, and the diesel-generator sets are not safety-related. Therefore, this BTP is not applicable.
- BTP ICSB 11 (PSB), "Stability of Offsite Power Systems" – See Subsection 8.2.2.1.
- BTP ICSB 18 (PSB), "Application of the Single Failure Criterion to Manually-Controlled Electrically-Operated Valves" - There are no safety-related, manually-controlled, electrically operated valves in the ESBWR design. All safety-related valves are

Table 8.1-1

Onsite Power System SRP Criteria Applicability Matrix

Applicable Criteria		IEEE Standard	Notes	Offsite Power System	AC (Onsite) Power System	DC (Onsite) Power System
GDC	2		7			X
GDC	4		7			X
GDC	5		1			
GDC	17		7, 8	X	X	X
GDC	18		7	X	X	X
GDC	50				X	X
10 CFR	50.34(f)(2)(v)		6			
10 CFR	50.34(f)(2)(xiii)		2			
10 CFR	50.34(f)(2)(xx)		2			
10 CFR	50.63		7			X
RG	1.6			X	X	X
RG	1.9		3			
RG	1.32	308~~, 1188~~	7			X
RG	1.47		7			X
RG	1.53	379,603	7			X
RG	1.63	242, 317, 741			X	X
RG	1.75	384	7			X
RG	1.81		1			
RG	1.106					
RG	1.118	338, 603	7			X
RG	1.128	485, 344, 323, ~~1187~~484				X
RG	1.129	450~~1188~~				X
RG	1.153	603	7			X
RG	1.155 (NUMARC 8700)		7, 9			X
RG	1.160 (NUMARC 93-01)			X	X	X
RG	1.204	665, 666, 1050, C62.23		X	X	
BTP	ICSB 4		2			

are designed as safety-related equipment in accordance with IEEE 308 (Reference 8.3-38) and IEEE 946 (Reference 8.3-1). The safety-related DC system is designed so that no single active failure in any division of the 250 VDC system results in conditions that prevent safe shutdown of the plant while a separate division has been taken out of service for maintenance.

The plant design and circuit layout of the DC systems provide physical separation of the equipment, cabling, and instrumentation essential to plant safety. Each 250 VDC battery is separately housed in a ventilated room apart from its charger, distribution, and ground detection panels. Equipment of each division of the DC distribution system is located in an area separated physically from the other divisions. All the components of safety-related 250 VDC systems are housed in Seismic Category I structures.

Safety-Related Batteries

In divisions 1, 2, 3, and 4, the two 250 volt safety-related batteries per division are together sized so that their total rated capacity will exceed the required battery capacity per division for 72-hour station blackout conditions. The DC system minimum battery terminal voltage at the end of the discharge period is 210 VDC (1.75 volts per cell). The maximum equalizing charge voltage for safety-related batteries is site specific and 282 VDC (2.35 volts per cell) as specified by the battery vendor (reference Table 8.3-4) and allowed by the voltage rating of the connected loads (inverters). The UPS inverters are designed to supply 120 VAC power with DC input less than the minimum discharge voltage (210 VDC) and greater than the maximum equalizing charge voltage, which is site specific (reference Table 8.3-4) (282 VDC)as specified by the battery vendor. The COL Applicant will specify the Safety-Related Battery float voltage and equalize voltage values in Table 8.3-4 (COL 8.3.4-1-A).

The safety-related batteries have sufficient stored capacity without their chargers to independently supply the safety-related loads continuously for the time periods stated above. Each distribution circuit is capable of transmitting sufficient energy to operate all required loads in that circuit. Batteries are sized for the DC load in accordance with IEEE Standard 485 (Reference 8.3-2) with an expected 20-year service life and include margin to compensate for uncertainty in determining the battery state of charge. The battery banks are designed to permit the replacement of individual cells.

The safety-related batteries meet the qualification requirements of IEEE 535 (Reference 8.3-3), and are installed in accordance with IEEE 1187 (Reference 8.3-9)Section 3.11.

Safety-Related Battery Chargers

The safety-related battery chargers are full wave rectifiers. The housings are freestanding, NEMA Type 1, and are ventilated. The chargers are suitable for float charging the batteries. The chargers operate from a 480 volt, 3 phase, 60 Hz supply. The power for each divisional battery charger is supplied by that division's dedicated Isolation Power Center. The standby battery charger is used to equalize either of its associated divisional batteries, or as a replacement to the normal charger associated with that battery.

Standby chargers are supplied from the same Isolation Power Center as the normal charger.

Each battery charger is capable of restoring its battery after a bounding design basis event discharge within 24 hours to a state that the battery can perform its design basis function for subsequent postulated operational and design basis functions, while at the same time supplying the largest combined demands associated with the individual battery.

The battery chargers are the constant voltage type, adjustable between 240 and 290 volts, with the capability of operating as battery eliminators. The battery eliminator feature is incorporated as a precautionary measure to protect against the effects of inadvertent disconnection of the battery. The battery chargers are designed to function properly and remain stable on the disconnection of the battery. Variation of the charger output voltage is less than ± 1 percent with or without the battery connected. The maximum output ripple for the charger is 30 millivolts RMS with the battery, and less than 2% RMS without the battery.

The battery charger's output is of a current limiting design. The battery chargers are designed to prevent their AC source from becoming a load on the batteries because of power feedback from loss of AC power. The battery charger's output voltage is protected against overvoltage by a high voltage shutdown circuit. The overvoltage protection feature is incorporated to protect equipment from damage caused by high voltage. When high voltage occurs, the unit disconnects the auxiliary voltage transformer, which results in charger shutdown. Loss of charger input voltage and charger shutdown is alarmed in the control room.

Ventilation

A safety-related ventilation system is not required for the batteries to perform their safety-related functions. However, battery rooms are ventilated by a system designed to remove the ~~minor amounts of~~hydrogen gas produced during the charging of batteries. The system is designed to preclude the possibility of hydrogen accumulation. (See Subsection 9.4.6).

Inspection, Maintenance, and Testing

An initial composite test of the onsite DC power systems is a prerequisite to initial fuel loading. This test verifies that each division's total battery capacity is sufficient to satisfy a design basis load demand profile under the conditions of a LOCA and loss of preferred power. Battery capacity tests are conducted in accordance with ~~IEEE 1188 (Reference 8.3-8)~~IEEE 450 (Reference 8.3-42). These tests ensure that the batteries have the capacity to meet safety-related load demands.

In-service tests, inspections, and resulting maintenance of the DC power systems including the batteries, chargers, and auxiliaries are specified in the ESBWR Technical Specifications ~~that conform to IEEE 1188~~ that are based on IEEE 450 and manufacturer recommendations (see Reference 8.3-42).

Station Blackout

The station blackout scenario (defined in 10 CFR 50.63, Regulatory Guide 1.155 and Appendix B to SRP 8.2) includes the complete loss of all offsite and onsite AC power, but not the loss of available AC power buses fed by station batteries through inverters, as with the ESBWR. The ESBWR Design Bases rely upon battery power to achieve and maintain safe shutdown for 72 hours. The batteries are adequately sized for the station blackout loads. The station blackout safety analysis is provided in Subsection 15.5.5.

8.3.2.1.2 Nonsafety-Related Station Batteries and Battery Chargers

125V and 250V Nonsafety-Related DC Systems Configuration

Figure 8.1-2 shows the overall 125V and 250V nonsafety-related DC systems. The DC systems are operated ungrounded for increased reliability. Each of the DC systems has a battery, a battery charger, a standby battery charger, main DC distribution bus, and ground detection panel, except the 250 VDC load groups A and B. The A and B load groups each have two normal battery chargers, one standby battery charger, two batteries, a ground detection panel, and two DC distribution buses. The main DC distribution buses feed the local DC distribution panels, UPS inverter and/or DC motor control center.

The plant design and circuit layout of the nonsafety-related DC systems provide physical separation of the equipment, cabling and instrumentation associated with the load groups of nonsafety-related equipment. Each 125V and 250 VDC battery is separately housed in a ventilated room apart from its charger, distribution, and ground detection panels. Equipment of each load group of the DC distribution system is located in an area separated physically from the other load groups.

The nonsafety-related DC power is required for control and switching functions such as the control of the main generator circuit breaker, 13.8 kV, 6.9 kV and 480V switchgear, DC motors, control relays, meters and indicators.

Nonsafety-Related Batteries

The 125 volt nonsafety-related batteries are sized for 2-hour duty cycles at a discharge rate of 2 hours, based on a terminal voltage of 1.75 volts per cell. The DC system minimum battery terminal voltage at the end of the discharge period is 105 volts. The maximum equalizing charge voltage for 125V batteries is specified by the battery vendor~~141 VDC~~.

The 250 volt nonsafety-related batteries are sized for 2-hour duty cycles at a discharge rate of 2 hours, based on a terminal voltage of 1.75 volts per cell. The DC system minimum battery terminal voltage at the end of the discharge period is 210 volts. The maximum equalizing charge voltage for 250V batteries is specified by the battery vendor~~282 VDC~~.

The nonsafety-related batteries have sufficient stored capacity without their chargers to independently supply their loads continuously for at least 2 hours. Each distribution circuit is capable of transmitting sufficient energy to start and operate all required loads in that circuit.

The batteries are sized so that the sum of the required loads does not exceed the battery ampere-hour rating, or warranted capacity at end-of-installed-life with 100% design demand. The battery banks are designed to permit replacement of individual cells .

Nonsafety-Related Battery Chargers

The nonsafety-related battery chargers are full wave rectifiers or an acceptable alternate design. The housings are freestanding, NEMA Type 1, and are ventilated. The chargers are suitable for float charging the batteries. The chargers operate from a 480 volt, 3 phase, 60 Hz supply. Each normal charger is supplied from a separate power center than its standby charger, and is backed by the standby diesel-generator.

Standby chargers are used to equalize battery charging. Standby chargers are supplied from a different power center than the normal charger.

The battery chargers are the constant voltage type, with the 125 VDC system chargers having a voltage adjustable between 120 and 145 volts and the 250 VDC system chargers having a voltage adjustable between 240 and 290 VDC, with the capability of operating as battery eliminators. The battery eliminator feature is incorporated as a precautionary measure to protect against the effects of inadvertent disconnection of the battery. The battery chargers are designed to function properly and remain stable on the disconnection of the battery. Variation of the charger output voltage is less than ± 1 percent with or without the battery connected.

The battery charger's output is of a current limiting design. The battery chargers are designed to prevent their AC source from becoming a load on the batteries caused by power feedback from a loss of AC power. The battery charger's output voltage is protected against overvoltage by a high voltage shutdown circuit. The overvoltage protection feature is incorporated to protect equipment from damage caused by high voltage. When high voltage occurs, the unit disconnects the auxiliary voltage transformer, which results in charger shutdown. Loss of charger input voltage and charger shutdown is alarmed in the control room.

Ventilation

Battery rooms are ventilated by a system designed to remove the ~~minor amounts of~~hydrogen gas produced during the charging of batteries. The system is designed to preclude the possibility of hydrogen accumulation. Refer to Subsection 9.4.7.

8.3.2.2 Analysis

8.3.2.2.1 Safety-Related DC Power Systems

The 480 VAC power supplies for the divisional battery chargers are from the individual Isolation Power Centers to which the particular 250 VDC system belongs (Figure 8.1-3). These Isolation Power Centers are fed directly from the PIP nonsafety-related buses, which are backed up by the standby diesel generators. In this way, separation between the independent systems is maintained and the AC power provided to the chargers can be from either preferred or standby AC power sources.

The DC system is arranged so that the probability of an internal system failure resulting in loss of that DC power system is extremely low. A ground detection system is employed for prompt detection of grounds. Important system components are either self-alarming on failure, or capable of clearing faults, or being tested during service to detect faults. Each battery set is located in its own ventilated battery room. All abnormal conditions of important system parameters such as system grounds, charger failure and low bus voltage are alarmed in the main control room and/or locally.

8.3.2.2.2 Regulatory Requirements and Guides

The following analyses demonstrate compliance of the safety-related Divisions 1, 2, 3 and 4 DC power systems to NRC GDC, NRC Regulatory Guides, and other criteria consistent with the SRP. The analyses establish the ability of the system to sustain credible single active failure with one division already out of service and the remaining two divisions retain their capacity to function for 72 hours before requiring recharge.

The following list of criteria is addressed in accordance with Table 8.1-1, which is based on Table 8-1 of the SRP. In general, the ESBWR is designed in accordance with all criteria. Any exceptions or clarifications are so noted.

GDC:

- GDC 2, 4, 17, 18 and 50 - The DC power system complies with these GDC, which are generically addressed in Subsection 8.1.5.2.4.

Regulatory Guides:

- Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems." The ESBWR Standard Plant does not need or have any safety-related standby AC power sources; ~~therefore this Regulatory guide is not applicable to the ESBWR design (see Table 8.1-1). However, t~~however, portions pertaining to the safety-related DC system are addressed within Subsection 8.3.2. The ESBWR offsite and onsite nonsafety-related power sources do comply with independence and redundancy between their sources and distribution systems.
- Regulatory Guide 1.32, "Criteria for Power Systems for Nuclear Power Plants." Safety-related DC power sources are provided to support passive core cooling and containment integrity safety functions. No offsite or diesel-generator-derived AC power is required for 72 hours.
- Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems."
- Regulatory Guide 1.53, "Application of the Single Failure Criteria to Safety Systems."
- Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants."
- Regulatory Guide 1.75, "Criteria for Independence of Electrical Safety Systems." Safe shutdown relies only upon DC-derived power and meets the design requirements for physical independence.
- Regulatory Guide 1.106, "Thermal Overload Protection for Electrical Motors and Motor Operated Valves." The ESBWR does not require electric motors or motor operated valves to perform any safety-related function, therefore this regulatory guide is not applicable.
- Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems." (See Subsection 13.5.2 for Operating and Maintenance Procedures and Chapter 16 for Technical Specifications.)
- Regulatory Guide 1.128, "Installation Designs and Installation of Large Lead Storage Batteries for Nuclear Power Plants."~~ The ESBWR Valve Regulated Lead Acid (VRLA) batteries' recombination of hydrogen effectiveness is 99% while battery room temperature and charging voltage are within specified vendor limits during charging evolutions. IEEE 344, IEEE 323, and IEEE 1187 apply to VRLA batteries. IEEE 484 is not applicable for VRLA batteries.~~

- Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants." The ESBWR design allows for periodic testing, maintenance and replacement of batteries in accordance with IEEE 1188. IEEE 450 is not applicable for VRLA batteries.
- Regulatory Guide 1.153, "Criteria for Safety Systems."
- Regulatory Guide 1.155, "Station Blackout," The ESBWR uses battery power to achieve and maintain safe shutdown. Thus, the ESBWR meets the intent of Regulatory Guide 1.155. The Station Blackout evaluation is provided in Subsection 15.5.5.

Branch Technical Positions (BTPs):

- BTP ICSB 21, "Supplemental Guidance for Bypass and Inoperable Status Indication for Engineered Safety Features Systems."

The DC power system is designed consistent with this criterion.

Other SRP Criteria:

Consistent with Table 8-1 of the SRP, there are no other criteria applicable to DC power systems.

8.3.3 Fire Protection of Cable Systems

The basic concept of fire protection for the cable system in the ESBWR design is that it is incorporated into the design and installation rather than added onto the systems. Fire protection is built into the system by cable separation; by limiting cable tray fill; by limiting cable ampacity to levels that prevent overheating and insulation failures (and resultant possibility of fire); and by use of fire resistant and non-propagating cable insulation. Fire suppression systems (for example, automatic sprinkler systems) are provided as defined in Subsection 9.5.1.2. Further circuit analysis is provided in Section 9A.6.

8.3.3.1 Resistance of Cables to Combustion

The electrical cable insulation is designed to resist the onset of combustion by choice of insulation and jacket materials, which have flame-resistive and self-extinguishing characteristics. Polyvinyl chloride and neoprene cable insulation are not used in the ESBWR. Each power, control, and instrumentation cable is specified to pass the vertical tray flame test in accordance with IEEE 1202 (Reference 8.3-11). All cable trays are fabricated from noncombustible material.

8.3.3.2 Cables and Raceways

Power and control cables are specified for continuous operation at conductor temperature not exceeding 90°C (194°F) and to withstand an emergency overload temperature of up to 130°C (266°F) in accordance with ICEA S-95-658/NEMA WC-70 (Reference 8.3-5). The base ampacity rating of the cables is established as published in IEEE 835 (Reference 8.3-6) and ICEA P-54-440/NEMA WC-51 (Reference 8.3-7).

Cables are specified to continue to operate at 100% relative humidity with a service life expectancy of 60 years. Safety-related cables are designed to survive the LOCA ambient condition at the end of the 60-year life span. Certified proof tests are performed on cables to

8.3.4 COL Information

8.3.4-1-A Safety Related Battery Float and Equalize Voltage values

The COL Applicant will specify the Safety-Related Battery float voltage and equalize voltage values in Table 8.3-4 (Subsection 8.3.2.1.1).~~None~~

8.3.5 References

8.3-1 IEEE 946, "Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations."

8.3-2 IEEE 485, "Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications."

8.3-3 (Deleted)~~IEEE 535, "Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations."~~

8.3-4 IEEE 383, "Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations."

8.3-5 ICEA S-95-658/NEMA WC-70, "Nonshielded 0-2kV Cables."

8.3-6 IEEE 835, "Standard Power Cable Ampacity Tables."

8.3-7 ICEA P-54-440/NEMA WC-51, "Ampacities of Cables in Open-top Cable Trays."

8.3-8 (Deleted)~~IEEE 1188, "Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications."~~

8.3-9 (Deleted)~~IEEE 1187, "Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications."~~

8.3-10 IEEE 384, "Standard Criteria for Independence of Class 1E Equipment and Circuits."

8.3-11 IEEE 1202, "Standard for Flame-Propagation Testing of Wire and Cable."

8.3-12 IEEE Standard C57.12.00, "Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers."

8.3-13 IEEE 323, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."

8.3-14 IEEE 344, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

8.3-15 IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

8.3-16 IEEE 379, "Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems."

8.3-17 NEMA ICS-2, "Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts."

8.3-40 IEEE C37.32, "High-Voltage Air Disconnect Switches Interrupter Switches, Fault Initiating Switches, Grounding Switches, Bus Supports and Accessories Control Voltage Ranges-Schedules of Preferred Ratings, Construction Guidelines and Specifications."

8.3-41 IEEE 484, "IEEE Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations."

8.3-42 IEEE 450, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations."

Table 8.3-3

250VDC Safety-Related Battery Nominal Load Requirements

	DC Power (Watts)							
	Normal	**0-1 min DBA**	**1-5 min**	**5-7 min**	**7-15 min**	**15-17 min**	**17-60 min**	**1-72 hours**
Division 1	24697	26259	19618	22118	20501	20618	20501	20501
Division 2	24697	26259	19618	22118	20501	20618	20501	20501
Division 3	22040	23604	23993	26180	24563	24680	24563	24563
Division 4	22040	23604	23993	25805	24188	24305	24188	24188

Notes:

(1) The loads assumed for each divisional battery are estimated nominal values. These nominal loads are based on assumed equipment vendor information, best engineering load estimates, and preliminary Q-DCIS load values.

(2) The loads for RMUs powering solenoid valves and squib valves are based on the assumption that the solenoid valves would be operable (energized) for 72 hours. The Q-DCIS design limits the energized state of the squib valves to 2 minutes (times 5-7 minutes and 15-17 minutes). This will conservatively encompass all design basis scenarios.

(3) 60 degrees F is the minimum operable temperature used in the sizing calculation for the safety-related batteries in the four divisions shown above.

(4) The sizing calculation used for ESBWR safety-related lead acid batteries is the methodology of IEEE 485, which includes an overall margin that is conservative and bounding. The final margins of safety are factors greater than the IEEE standard required, based on the industry uncertainties of deep cycle discharge batteries. Ageing factor, Temperature factor, design margin factor, state of charge, and the ability to recharge in 24 hours (IEEE 946) were all employed in this calculation.

Table 8.3-4

Safety-Related DC and UPS Nominal Component Data

a. Batteries	
	Two 250 VDC batteries per division, (two parallel strings of 120 ~~valve regulated~~ lead acid cells per string ~~battery,~~and 240 cells per battery) 6000 Ah. per battery, 12,000 Ah per division (8 hour rate to 1.75 V/cell @77°F) and qualified to a 72 hour duty cycle.
b. Charger	
	AC input - 480 VAC, 3-phase, 60 Hz DC output - 250 VDC, 500 A continuous - float voltage ~~2.20 V/cell~~is a site specific value ~~@90°F or above to 2.35 V/cell @40°F or below (temperature compensated from 2.24 V/cell~~ @77°F~~)~~ (COL 8.3.4-1-A) - maximum equalizing charge voltage ~~2.35 V/cell~~is a site specific value @77°F (COL 8.3.4-1-A)
c. Uninterruptible Power Supply (UPS)	
	i) Inverter - 40 kVA with 250 VDC input and 120 VAC, 60 Hz output - AC output voltage regulation of ±1% steady state - output frequency variation within ±0.1% of nominal 60 Hz - total harmonic distortion <5% ~~ii) Regulating Transformer~~(Deleted) ~~40 kVA 480/120 VAC, ±1%~~(Deleted)

Notes:

(1) See Figures 8.1-3 and 8.1-4 for the configurations of the safety-related DC and UPS systems.

Table 16.0-1-A (page 6 of 10)
COL - Applicant Open Items

COL Item	Description	Reviewer's Note
3.7.4-2	Turbine Bypass Valve cycling frequency	For SR 3.7.4.1, a Frequency of 31 days shall be specified unless an evaluation is performed and approved by the NRC using sufficient industry, site-specific, or manufacturer's operating experience or reliability studies that justifies extension to a longer Frequency (e.g., 92 days), a Reference to the evaluation and NRC approval is added to these Bases, and a commitment is made to establish appropriate procedural controls governing valve operation that support the extended Frequency.
3.7.6-1	SCRRI/SRI COLR-MCPR penalty option for inoperable control rods	An MCPR penalty is optional based upon completion of the required analyses to demonstrate that, given the specific inoperabilities that can be postulated and the number of selected control rods affected for each inoperability, sufficient margin exists to operate the unit with an MCPR penalty without exceeding the Fuel Cladding Integrity Safety Limit (FCISL) and the cladding 1% plastic strain limit during the licensing basis events requiring an acceptable operating MCPR limit as an initial condition. NRC approved analytical methods that evaluate the MCPR penalty must be included in TS 5.6.3, COLR, list of methods.
3.8.1-1	Acceptance criteria for battery charger testing.	Provide acceptance criteria for battery charger testing consistent with battery size.
3.8.1-2	Acceptance criteria for verification that battery is fully charged.	Provide acceptance criteria for verification that battery is fully charged consistent with battery manufacturer recommendations. Use of float current monitoring option requires that battery manufacturer confirm acceptability and acceptance criteria and that battery capacity includes margin for state of charge uncertainty
3.8.1-3	~~Use of a modified performance test for verification of battery capacity~~Deleted	~~Provide requirements for use of a modified performance test for verification of battery capacity consistent with battery manufacturer recommendations.~~Deleted
3.8.1-4	Battery Cell Parameters	Provide battery cell parameters consistent with manufacturer specifications.
3.8.1-5	Battery margin for aging factor and state of charge uncertainty.	Provide battery margin including aging factor and state of charge uncertainty.
3.8.3-1	Acceptance criteria for verification that battery is fully charged.	Provide acceptance criteria for verification that battery is fully charged consistent with battery manufacturer recommendations. Use of float current monitoring option requires that battery manufacturer confirm acceptability and acceptance criteria and that battery capacity includes margin for state of charge uncertainty
3.8.3-2	~~Use of a modified performance test for verification of battery capacity~~Deleted	~~Provide requirements for use of a modified performance test for verification of battery capacity consistent with battery manufacturer recommendations.~~Deleted

3.8 ELECTRICAL POWER SYSTEMS

3.8.1 DC Sources - Operating

LCO 3.8.1 DC Sources shall be OPERABLE to support the three Divisions of DC and Uninterruptible AC Electrical Power Distribution required by LCO 3.8.6, "Distribution Systems – Operating."

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or both required battery chargers inoperable on one required division.	A.1 Restore battery terminal voltage to greater than or equal to the minimum established float voltage. AND	2 hours
COL 16.0-1-A 3.8.1-2	A.2 Verify battery ~~is fully charged~~[float current < 30 amps].	Once per 24 hours
	AND A.3 Restore required battery chargers to OPERABLE status.	72 hours

B. One or more DC Sources inoperable on one required division for reasons other than Condition A. <u>OR</u> Required Action and associated Completion Time of Required Action A.1 not met.	B.1 Restore DC Sources to OPERABLE status.	24 hours
CONDITION	REQUIRED ACTION	COMPLETION TIME
C. One or more DC Sources inoperable on two or more required divisions. <u>OR</u> Required Action and associated Completion Time of Required Action A.2 or A.3, or Condition B not met.	C.1 Be in MODE 3. <u>AND</u> C.2 Be in MODE 5.	12 hours 36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.1.1	Verify each required battery terminal voltage is greater than or equal to the minimum established float voltage.	~~31~~<u>7</u> days

SR 3.8.1.2	Verify each required battery charger supplies ≥ rated 500 amps at greater than or equal to the minimum established float voltage[for ≥ [4] hours]. COL 16.0-2-H1-A 3.8.1-1 OR Verify each required battery charger can recharge the battery to the fully charged state within 24 hours while supplying the largest combined demands of the various continuous steady state loads, after a battery discharge to the bounding design basis event discharge state.	24 months

SURVEILLANCE		FREQUENCY
SR 3.8.1.3	[--------------------- - NOTE - The modified performance discharge test in SR 3.8.3.6 may be performed in lieu of SR 3.8.1.3. ---------------------] COL 16.0-2-H1-A 3.8.1-3 Verify each required battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency loads for the design duty cycle when subjected to a battery service test.	24 months
SR 3.8.1.4	Verify the output diode for each required battery charger and safety-related rectifier connected to the Isolation Power Center bus prevents reverse current flow.	24 months
SR 3.8.1.5	Verify each required DC Source can supply the 120 VAC Uninterruptible AC Power inverter for ≥ 4 hours.	24 months

3.8 ELECTRICAL POWER SYSTEMS

3.8.3 Battery Parameters

LCO 3.8.3 Battery parameters shall be within limits.

APPLICABILITY: When associated DC Sources are required to be OPERABLE.

ACTIONS

- NOTE -

Separate Condition entry allowed for each battery.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or two batteries on one required division with one or more battery cells float voltage < [2.142.09] V.	A.1 Perform SR 3.8.1.1. AND	2 hours
	A.2 Perform SR 3.8.3.1. AND	2 hours
COL 16.0-2-H1-A 3.8.3-3	A.3 Restore affected cell voltage ≥ [2.142.09] V.	24 hours
COL 16.0-1-A 3.8.3-1 B. SR 3.8.3.1 not met for oOne or two batteries on one required division with [float current > 30 amps].	B.1 Perform SR 3.8.1.1. AND	2 hours
	B.2 Verify battery is fully chargedRestore battery [float current(s) < 30 amps].	24 hours
C. One or two batteries on one required division with charger voltage greater than maximum established design limit.	C.1 Restore charger voltage to less than or equal to maximum established design limit.	7 days

CONDITION	REQUIRED ACTION	COMPLETION TIME
- NOTE - Required Action C.2 shall be completed if electrolyte level was below the top of plates. C. One or two batteries on one required division with one or more cell electrolyte level(s) less than minimum established design limits.	- NOTE - Required Actions C.1 and C.2 are only applicable if electrolyte level was below the top of plates. C.1 Restore electrolyte level to above top of plates. AND C.2 Verify no evidence of leakage. AND C.3 Restore electrolyte level to greater than or equal to minimum established design limits.	8 hours 12 hours 31 days
D. One or two batteries on one required division with battery ~~room average cell~~pilot cell electrolyte temperature less than minimum established design limit.	D.1 Restore battery ~~roomaverage cell~~pilot cell electrolyte temperature to greater than or equal to minimum established design limit.	12 hours
E. One or more required batteries in redundant required divisions with battery parameters not within limits.	E.1 Restore battery parameters in all but one required division to within limits.	2 hours

COL 16.0-2-H1-A 3.8.3-3 COL 16.0-1-A 3.8.3-1	F. Required Action and associated Completion Time of Condition A, B, C, D, or E not met. OR Required battery with one or more battery cell float voltage < [2.142.09] V and SR 3.8.3.1 not met[float current > 30 amps].	F.1	Declare associated battery inoperable.	Immediately

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE		FREQUENCY
	SR 3.8.3.1	--- **- NOTE -** Not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.1.1. ---	
COL 16.0-2-H1-A 3.8.3-1		Verify each required battery is fully charged as indicated by [stabilized charging current or [float current < 30 ampswithin limits].	317 days
COL 16.0-2-H1-A 3.8.3-3	SR 3.8.3.2	Verify each required battery pilot cell float voltage is ≥ [2.142.09] V.	31 days
	SR 3.8.3.3	Verify each required battery terminal voltage is less than or equal to maximum established design limit.Verify each battery connected cell electrolyte level is greater than or equal to minimum established design limits.	31 days

SURVEILLANCE		FREQUENCY
SR 3.8.3.4	Verify each required battery room average cellpilot cell electrolyte temperature is greater than or equal to minimum established design limit.	31 days
SR 3.8.3.5 COL 16.0-2-H1-A 3.8.3-3	Verify each required battery connected cell float voltage is ≥ [2.142.09] V.	92 days
SR 3.8.3.6 COL 16.0-2-H1-A 3.8.3-4 COL 16.0-2-H 3.8.3-2	Verify each required battery capacity is ≥ [80]% of the manufacturer's rating when subjected to a performance discharge test or [a modified performance discharge test].	24 60 months AND 12 months when battery shows degradation or has reached 85% of the expected life with capacity < 100% of manufacturer's rating AND 24 months when battery has reached [85]% of the expected life with capacity ≥ 100% of manufacturer's rating

5.5 Programs and Manuals

5.5.10 Battery Monitoring and Maintenance Program

This Program provides for battery restoration and maintenance, which includes the following:

COL 16.0-1-A 5.5.10-1

a. With battery cell float voltage [< ~~[2.18~~2.13] V, actions to restore cell(s) to [≥ ~~[2.18~~2.13] V and perform SR 3.8.3.5, ~~and~~

b. Actions to equalize and test battery cells that had been discovered with electrolyte level below the minimum established design limit;

c. Limits on average electrolyte temperature, battery connection resistance, and battery terminal voltage; and

d. A requirement to obtain specific gravity readings of all cells at each discharge test, consistent with manufacturer recommendations.

~~b. Actions to determine the cause and correct when cell temperatures deviate more than 3°C (5°F) from each other.~~

5.5.11 Setpoint Control Program (SCP)

a. The Setpoint Control Program (SCP) implements the regulatory requirement of 10 CFR 50.36(~~d~~c)(1)(ii)(A) that technical specifications will include items in the category of limiting safety system settings (LSSS), which are settings for automatic protective devices related to those variables having significant safety functions.

COL 16.0-~~2-H~~1-A 5.5.11-1

b. The Limiting Trip Setpoint (LTSP), Nominal Trip Setpoint ($NTSP_F$), Allowable Value (AV), As-Found Tolerance (AFT), and As-Left Tolerance (ALT) for each Technical Specification required automatic protection instrumentation function shall be calculated in conformance with the instrumentation setpoint methodology previously reviewed and approved by the NRC in NEDE- 33304P-A, "GEH ABWR/ESBWR Setpoint Methodology," [Revision #, dated Month dd, yyyy, (MLxxxxxxxxx)], and the conditions stated in the associated NRC safety evaluation, [Letter to GEH from NRC, Title, dated Month, dd, yyyy, (MLxxxxxxxxx)].

c. For each Technical Specification required automatic protection instrumentation function, performance of a CHANNEL CALIBRATION surveillance shall include the following:

1. The as-found value of the instrument channel trip setting shall be compared with the previous as-left value or the specified $NTSP_F$.

BASES

LCO (continued)

Three of the four Divisions of DC Sources are required to be OPERABLE to ensure the availability of the required power to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence (AOO) or a postulated Design Basis Accident (DBA). Loss of one of the required Divisions of DC Sources does not prevent the minimum safety function from being performed (Ref. 4).

APPLICABILITY

The DC Sources are required to be OPERABLE in MODES 1, 2, 3, and 4 to ensure safe unit operation and to ensure that:

a. Acceptable fuel design limits and reactor coolant pressure boundary limits are not exceeded as a result of AOOs; and

b. Adequate core cooling is provided, and containment integrity and other vital functions are maintained in the event of a postulated DBA.

The DC electrical power requirements for MODES 5 and 6 are addressed in the Bases for LCO 3.8.2, "DC Sources - Shutdown."

ACTIONS

A.1, A.2, and A.3

Condition A represents one required division with one or both required battery chargers inoperable (e.g., the voltage limit of SR 3.8.1.1 is not maintained) on one required division. The ACTIONS provide a tiered response that focuses on returning the battery to the fully charged state and restoring a fully qualified charger to OPERABLE status in a reasonable time period. Required Action A.1 requires that the battery terminal voltage be restored to greater than or equal to the minimum established float voltage within 2 hours. This time provides for returning the inoperable charger to OPERABLE status or providing an alternate means of restoring battery terminal voltage to greater than or equal to the minimum established float voltage. Restoring the battery terminal voltage to greater than or equal to the minimum established float voltage provides good assurance that, within ~~12~~ 24 hours, the battery will be restored to its fully charged condition (Required Action A.2) from any discharge that might have occurred due to the charger inoperability.

BASES

ACTIONS (continued)

A discharged battery having terminal voltage of at least the minimum established float voltage indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus, there is good assurance of fully recharging the battery within ~~12~~ 24 hours, avoiding a premature shutdown with its own attendant risk.

If established battery terminal float voltage cannot be restored to greater than or equal to the minimum established float voltage within 2 hours, and the charger is not operating in the current-limiting mode, a faulty charger is indicated. A faulty charger that is incapable of maintaining established battery terminal float voltage does not provide assurance that it can revert to and operate properly in the current limit mode that is necessary during the recovery period following a battery discharge event that the DC system is designed to withstand.

If the charger is operating in the current limit mode after 2 hours that is an indication that the battery is partially discharged and its capacity margins will be reduced. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within ~~12~~ 24 hours (Required Action A.2).

COL 16.0-~~2-H~~1-A
3.8.1-2

Required Action A.2 requires that the battery ~~be fully charged. A fully charged condition is achieved when [charging current has stabilized as indicated by three consecutive hourly current readings changing by < [0.5] amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Alternately, a fully charged condition is achieved when the float current is < [5.0] amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Either method verifies that a partially discharged battery has been fully recharged.]~~float current be verified as < [30] amps. This indicates that, if the battery had been discharged as the result of the inoperable battery charger, it has is now been fully recharged capable of supplying the maximum expected load requirement. The [30] amp value is based on returning the battery to [95]% charge and assumes a [5]% design margin for the battery. If at the expiration of the initial 24 hour period the battery is not returned to the fully charged condition this indicates there may be additional battery problems and the battery must be declared inoperable.

COL 16.0-1-A
3.8.1-5

must be brought to at least MODE 3 within 12 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.8.1.1

Verifying battery terminal voltage while on float charge helps to ensure the effectiveness of the battery chargers, which support the ability of the batteries to perform their intended function. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a fully charged state while supplying the continuous steady state loads of the associated DC subsystem. On float charge, battery cells will receive adequate current to optimally charge the battery. The voltage requirements are based on the nominal design voltage of the battery and are consistent with the minimum float voltage established by the battery

COL 16.0-2-H1-A 3.8.1-4

manufacturer ([2.23]2.22 Vpc or [267.6]266.4 V at 25°C (77°F) at the battery terminals]). Minimum established float voltages are temperature-compensated as a function of battery [room] temperature and are provided in the manufacturer operating manual. This voltage maintains the battery in a condition that supports maintaining battery life, [(expected to be approximately 20 years)]. The 317 day Frequency is consistent with manufacturer recommendations and IEEE-1188 (Ref. 7).

COL 16.0-2-H 3.8.1-5

SR 3.8.1.2

This SR verifies the design capacity of the battery chargers. According to Regulatory Guide 1.32 (Ref 87), the battery charger supply is recommended to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the unit during these demand occurrences. The minimum required amperes and duration ensures that these requirements can be satisfied.

This SR provides two options. One option requires that each battery charger be capable of supplying [300 or 350]500 amps] at the minimum established float voltage [for [4] hours]. The ampere requirements are based on the output rating of the chargers. The voltage requirements are based on the charger voltage level after a response to a loss of AC power. The time period is sufficient for the charger temperature to have stabilized and to have been maintained for [at least [2] hours].

COL 16.0-2-H1-A 3.8.1-1

SURVEILLANCE REQUIREMENTS (continued)

The other option requires that each battery charger be capable of recharging the battery after a service test coincident with supplying the largest combined demands of the various continuous steady state loads (irrespective of the status of the plant during which these demands occur). This level of loading may not normally be available following the battery service test and will need to be supplemented with additional loads. The duration for this test may be longer than the charger sizing criteria since the battery recharge is affected by float voltage, temperature, and the exponential decay in charging current. The battery is recharged when the requirements of SR 3.8.3.1 are met.

The Surveillance Frequency is acceptable, given the unit conditions required to perform the test and the other administrative controls existing to ensure adequate charger performance during these 24-month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

SR 3.8.1.3

A battery-service test is a special test of the battery's capability, as found, to satisfy the design requirements (battery duty cycle) of the 250 VDC power system. The discharge rate and test length corresponds to the design duty cycle requirements ~~as specified in Reference 7~~. The Surveillance Frequency of 24 months is consistent with the recommendations of Regulatory Guide 1.32 (Ref. ~~8~~7).

COL 16.0-2-H1-A 3.8.1-3

~~[A Note to SR 3.8.1.3 allows the once-per-24-month performance of SR 3.8.3.6 in lieu of SR 3.8.1.3. This substitution is acceptable because SR 3.8.3.6 represents a more severe test of battery capacity than SR 3.8.1.3.]~~

SR 3.8.1.4

Operability of a DC Source requires that the output diodes for the associated battery chargers and safety-related rectifiers prevent reverse current flow from the DC Source to the associated IPC bus when the IPC bus is de-energized or has degraded voltage. This function is required to prevent degraded conditions on the nonsafety-related AC power system from affecting the safety-related DC power system. This SR is not required for battery chargers and safety-related rectifiers that are not connected to the IPC bus. This SR is also not required for standby battery chargers that are not connected to the 250 VDC bus. The 24 month Frequency is based on engineering judgment.

SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.1.5

This SR verifies that each required DC Source can supply the 120 VAC Uninterruptible AC Power inverter for ≥ 4 hours. The 120 VAC Uninterruptible AC Power inverters are normally supplied by the safety-related rectifiers. The circuit between the DC source and the inverter is not tested during either the battery charger capacity test (SR 3.8.1.2) or the battery service test (SR 3.8.1.3). Failure of the circuit between the DC Source and the 120 VAC Uninterruptible AC Power inverter, which includes the diode that separates the output of the safety-related rectifier from the DC source, could prevent the DC source from performing its required safety function. The 24 month Frequency is based on engineering judgment.

REFERENCES

1. Regulatory Guide 1.6~~, March 10, 1971~~.

2. IEEE Standard 308~~, 1978~~.

3. IEEE Standard 485.

4. Chapter 8.

5. Chapter 6.

6. Chapter 15.

7. ~~IEEE Standard 1188.~~

~~8.~~ Regulatory Guide 1.32~~, February 1977~~.

B 3.8 ELECTRICAL POWER SYSTEMS

B 3.8.3 Battery Parameters

BASES

BACKGROUND

This LCO delineates the limits on battery float current and float voltage, individual cell voltage, battery room average cellelectrolyte temperature, and battery capacity for the DC source batteries. A discussion of these batteries and their OPERABILITY requirements is provided in the Bases for LCO 3.8.1, "DC Sources - Operating" and LCO 3.8.2, "DC Sources - Shutdown." In addition to the limitations of this Specification, the Battery Monitoring and Maintenance Program also implements a program specified in Specification 5.5.10 for monitoring various battery parameters that is based on the recommendations of IEEE Standard 1188, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications" (Ref. 1).

COL 16.0-2-H1-A 3.8.3-3

The battery cells are of flooded lead acid construction with a nominal specific gravity of [1.240]. This specific gravity corresponds to The battery cells that have an open circuit battery voltage of approximately [256.8]249.6 V for [120] cell battery (i.e., cell voltage of [2.139]2.07 to 2.09 volts per cell (Vpc))]. The open circuit voltage is the voltage maintained when there is no charging or discharging. Once fully charged with its open circuit voltage [≥ [2.139]2.07 to 2.09 Vpc], the battery cell will maintain its capacity [for [30] days] without further charging per manufacturer's instructions. However, optimal long-term performance is obtained by maintaining a float voltage [2.232.22 to 2.252.24] Vpc at 25°C (77°F)]. This provides adequate over-potential, which [limits the formation of lead sulfate and self-discharge]. The nominal float voltage [of [2.24]2.23 Vpc at 25°C (77°F) corresponds to a total float voltage output of [268.8]267.6 V for a [120] cell battery as discussed in Chapter 8 (Ref. 21)].

APPLICABLE SAFETY ANALYSES

The initial conditions of Design Basis Accident (DBA) and transient analyses in Chapter 6 (Ref. 32) and Chapter 15 (Ref. 43) assume that Engineered Safety Feature (ESF) systems are OPERABLE. The DC Sources provide the emergency 250 VDC power to the DC Electrical Power Distribution System, which supplies power through the inverters to the Uninterruptible 120 VAC Power buses. Uninterruptible 120 VAC Power supports Q-DCIS and the control power for safety-related systems.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The OPERABILITY of the DC sources is consistent with the initial assumptions of the accident analyses and is based upon meeting the design basis of the unit as described in the Bases for LCO 3.8.1, "DC Sources - Operating" and LCO 3.8.2, "DC Sources - Shutdown."

Since battery parameters support the operation of the DC sources, they satisfy Criterion 3 of 10 CFR 50.36(d)(2)(ii).

LCO

Battery parameters must remain within acceptable limits to ensure availability of the required DC sources to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence or a postulated DBA. Battery parameter limits are conservatively established, allowing continued DC source function even with limits not met. Additional preventative maintenance, testing, and monitoring are performed in accordance with Specification 5.5.10, Battery Monitoring and Maintenance Program.

APPLICABILITY

The battery parameters are required solely for the support of the associated DC sources. Therefore, battery parameter limits are only required when the DC sources are required to be OPERABLE. Refer to Applicability discussion in Bases for LCO 3.8.1 and LCO 3.8.2.

ACTIONS

A.1, A.2, and A.3

COL 16.0-~~2-H~~1-A
3.8.3-3

With one or more cells in one or more batteries in one required division < [~~2.14~~2.09] V, the battery cell is degraded. Within 2 hours, verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage (SR 3.8.1.1) and of the overall battery state of charge by monitoring the battery float charge current (SR 3.8.3.1). This assures that there is still sufficient battery capacity to perform the intended function. Therefore, the affected battery is not required to be considered inoperable solely as a result of one or more cells in one or more batteries < [~~2.14~~2.09] V, and continued operation is permitted for a limited period up to 24 hours.

BASES

ACTIONS (continued)

Since the Required Actions only specify "perform," a failure of SR 3.8.1.1 or SR 3.8.3.1 acceptance criteria does not result in this Required Action not met. However, if one of the SRs is failed, the appropriate Condition(s), depending on the cause of the failures, is entered. If SR 3.8.3.1 is failed, then there is not assurance that there is still sufficient battery capacity to perform the intended function and the battery must be declared inoperable immediately.

B.1 and B.2

COL 16.0-1-A
3.8.3-1

One or two batteries on one required division with [float current > 30 amps]~~When SR 3.8.3.1 is not met, it~~ indicates that a partial discharge of the battery has occurred. This may be due to a temporary loss of a battery charger or possibly due to one or more battery cells in a low voltage condition reflecting some loss of capacity. Within 2 hours, verification of the required battery charger OPERABILITY is made by monitoring the battery terminal voltage. If the terminal voltage is found to be less than the minimum established float voltage there are two possibilities, the battery charger is inoperable or is operating in the current limit mode. LCO 3.8.1, Condition A, addresses charger inoperability. If the charger is operating in the current limit mode after 2 hours that is an indication that the battery has been substantially discharged and likely cannot perform its required design functions. The time to return the battery to its fully charged condition in this case is a function of the battery charger capacity, the amount of loads on the associated DC system, the amount of the previous discharge, and the recharge characteristic of the battery. The charge time can be extensive, and there is not adequate assurance that it can be recharged within 24 hours (Required Action B.2). The battery must therefore be declared inoperable.

COL 16.0-~~2-H~~1-A
3.8.3-3

If the float voltage is found not to be satisfactory and there are one or more battery cells with float voltage less than [~~2.14~~2.09] V, the associated "OR" statement in Condition F is applicable and the battery must be declared inoperable immediately. If float voltage is satisfactory and there are no cells less than [~~2.14~~2.09] V, there is good assurance that, within 24 hours, the battery will be restored to its fully charged condition (Required Action B.2) from any discharge that might have occurred due to a temporary loss of the battery charger.

~~COL 16.0-2-H~~
~~3.8.3-1~~

~~Required Action B.2 requires that the battery be fully charged. A battery is fully charged when [charging current has stabilized as indicated by three consecutive hourly current readings changing by < [0.5] amps while~~

BASES

the battery voltage is being maintained within the limits of SR 3.8.1.1. Alternately, a battery is fully charged when the float current is < [5.0] amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Either method verifies that a partially discharged battery has been fully recharged.]

ACTIONS (continued)

A discharged battery with float voltage (the charger setpoint) across its terminals indicates that the battery is on the exponential charging current portion (the second part) of its recharge cycle. The time to return a battery to its fully charged state under this condition is simply a function of the amount of the previous discharge and the recharge characteristic of the battery. Thus, there is good assurance of fully recharging the battery within 24 hours, avoiding a premature shutdown with its own attendant risk.

COL 16.0-2-H1-A 3.8.3-3

If the condition is due to one or more cells in a low voltage condition but still greater than [2.142.09] V and float voltage is found to be satisfactory, this is not indication of a substantially discharged battery and 24 hours is a reasonable time prior to declaring the battery inoperable.

Since Required Action B.1 only specifies "perform," a failure of SR 3.8.1.1 acceptance criteria does not result in the Required Action not met. However, if SR 3.8.1.1 is failed, the appropriate Condition(s), depending on the cause of the failure, is entered.

C.1, C.2, and C.3

With one or two batteries on one required division with charger voltage greater than maximum established temperature-compensated design limit, the batteries still retain sufficient capacity to perform the intended function. Therefore, the affected batteries are not required to be considered inoperable solely as a result of exceeding the temperature-compensated design limit. Within 7 days, the maximum established temperature-compensated design limit must be re-established.

At a constant battery voltage the charging current will increase as the temperature of the electrolyte increases. Therefore, cells in a battery at a higher temperature than others indicate a lower cell voltage. Continuous prolonged use at elevated temperatures will reduce the battery life. Based on tracking periods of excessive temperature-compensated terminal voltage, the impact on expected battery life can be monitored. With one or two batteries on one required division with one or more cells electrolyte level above the top of the plates, but below the minimum established design limits, the batteries still retain sufficient capacity to

BASES

perform the intended function. Therefore, the affected batteries are not required to be considered inoperable solely as a result of electrolyte level not met. Within 31 days, the minimum established design limits for electrolyte level must be re-established.

With electrolyte level below the top of the plates, there is a potential for dryout and plate degradation. Required Actions C.1 and C.2 address this potential (as well as provisions in Specification 5.5.10, Battery Monitoring and Maintenance Program). They are modified by a Note that indicates they are only applicable if electrolyte level is below the top of the plates. Within 8 hours, level is required to be restored to above the top of the plates. The Required Action C.2 requirement to verify that there is no leakage by visual inspection and the Specification 5.5.10.b item to initiate action to equalize and test in accordance with manufacturer's recommendation are taken from Annex D of IEEE Standard 450. They are performed following the restoration of the electrolyte level to above the top of the plates. Based on the results of the manufacturer's recommended testing, the battery may have to be declared inoperable and the affected cell(s) replaced.

ACTIONS (continued)

D.1

With one or two batteries on one required division with battery ~~room average cell~~pilot cell electrolyte temperature less than the minimum established design limit, 12 hours is allowed to restore the temperature to within limits. A low temperature results in reduced battery capacity. Since the battery is sized with margin, sufficient capacity exists to perform the intended function and the temporary degradation in battery capacity does not require the battery to be considered inoperable solely as a result of ~~room average cell~~pilot cell electrolyte temperature not met.

E.1

With one or more required batteries in redundant required divisions with battery parameters not within limits, there is not sufficient assurance that battery capacity has not been affected to the degree that the batteries can still perform their required function, given that redundant divisions are involved. With redundant divisions involved, this potential could result in a total loss of function on multiple systems that rely upon the batteries. The longer Completion Times specified for battery parameters on one required division not within limits are therefore not appropriate, and the parameters must be restored to within limits on all but one required division within 2 hours.

BASES

F.1

When any battery parameter is outside the allowances of the Required Actions for Condition A, B, C, D, or E, sufficient capacity to supply the maximum expected load requirement is not assured and the corresponding battery must be declared inoperable. Additionally, discovering one battery with one or more battery cells float voltage less than [2.142.09] V and SR 3.8.3.1 not met [float current > 30 amps] indicates that the battery capacity may not be sufficient to perform the intended functions. The battery must therefore be declared inoperable immediately.

COL 16.0-2-H1-A
3.8.3-3

COL 16.0-1-A
3.8.3-1

SURVEILLANCE REQUIREMENTS

SR 3.8.3.1

This SR verifies that a battery is fully charged as indicated by [stabilized charging current or float current within limits] while the battery is being maintained within the temperature-compensated float voltage limits required by SR 3.8.1.1.Verifying battery float current while on float charge is used to determine the state of charge of the battery. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a charged state. The float current requirements are based on the float current indicative of a charged battery. A fully charged condition exists when [charging current has stabilized as indicated by three consecutive hourly current readings changing by < [0.5] amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Alternately, a fully charged condition exists when the float current is < [5.0] amps while the battery voltage is being maintained within the limits of SR 3.8.1.1. Either method verifies that a battery is fully charged.] The [30] amp value is based on returning the battery to [95]% charge and assumes a [5]% design margin for the battery. Use of float current to determine the state of charge of the battery is consistent with IEEE-1188450 (Ref. 14) and manufacturer recommendations. The 317-day Frequency is consistent with IEEE-1188450 (Ref. 14).

COL 16.0-2-H1-A
3.8.3-1

This SR is modified by a Note that states the float current requirement is not required to be met when battery terminal voltage is less than the minimum established float voltage of SR 3.8.1.1. When this float voltage is not maintained, the Required Actions of LCO 3.8.1, ACTION A, are being taken, which provide the necessary and appropriate verifications of the battery condition. Furthermore, the float current limit [of [230] amps] is established based on the nominal float voltage value and is not directly applicable when this voltage is not maintained.

COL 16.0-2-H1-A
3.8.3-1

BASES

SR 3.8.3.2 and SR 3.8.3.5

COL 16.0-~~2-H~~1-A 3.8.3-3

Optimal long-term battery performance is obtained by maintaining a float voltage within established design limits provided by the battery manufacturer, which corresponds to nominally [~~266.8]~~267.6 V at the battery terminals, or ~~[2.24]~~2.23 Vpc at 25°C (77°F)]. This provides adequate over-potential, which [limits the formation of lead sulfate and self-discharge, which could eventually render the battery inoperable]. Float voltages below [~~2.18~~2.13 vpc at 25°C (77°F) but greater than ~~[2.14]~~2.09 Vpc], are addressed in Specification 5.5.10. SR 3.8.3.2 and SR 3.8.3.5 require verification that the cell float voltages are equal to or greater than the short-term absolute minimum voltage of [~~2.14~~2.09] Vpc. The Frequency for cell voltage verification every 31 days for pilot cell and 92 days for each connected cell is consistent with IEEE-450 (Ref. 4).~~manufacturer recommendations.~~ A pilot cell is selected in the series string to reflect the general condition of cells in the battery. The cell selected is the lowest cell voltage in the series string following each quarterly surveillance.

SURVEILLANCE REQUIREMENTS (continued)

SR 3.8.3.3

~~COL 16.0-1-A 3.8.3-3~~

~~This Surveillance verifies that the temperature-compensated terminal voltage is less than or equal to maximum established temperature-compensated design limit (i.e., [288 V at the battery terminals, or 2.40 Vpc at 25°C (77°F)]). Prolonged use with terminal voltage greater than the maximum established temperature-compensated design limit will reduce battery life. Based on tracking periods of excessive temperature-compensated terminal voltage, the impact on expected battery life can be monitored. The Frequency is consistent with manufacturer recommendations.~~The limit specified for electrolyte level ensures that the plates suffer no physical damage and maintains adequate electron transfer capability. The Frequency is consistent with IEEE-450 (Ref. 4).

SR 3.8.3.4

COL 16.0-~~2-H~~1-A 3.8.3-3

This Surveillance verifies that the required battery ~~average cell~~pilot cell electrolyte temperature is ~~above~~ greater than or equal to the design minimum temperature (i.e., [~~10~~15°C (~~50~~60°F)]) to assure the battery can provide the required current and voltage to meet the design requirements. Temperatures lower than assumed in battery sizing calculations reduce battery capacity. The Frequency is consistent with IEEE-450 (Ref. 4)~~manufacturer recommendations~~.

SR 3.8.3.6

A battery performance discharge test is a test of constant current capacity of a battery, normally done in the as found condition, after having been in service, to detect any change in the capacity determined by the acceptance test. The test is intended to determine overall battery degradation due to age and usage.

COL 16.0-2-H 3.8.3-2

[Either the battery performance discharge test or the modified performance discharge test is acceptable for satisfying SR 3.8.3.6; however, only the modified performance discharge test may be used to satisfy the battery service test requirements of SR 3.8.1.3.]

[A modified discharge test is a test of the battery capacity and its ability to provide a high rate, short duration load (usually the highest rate of the duty cycle). This will often confirm the battery's ability to meet the critical period of the load duty cycle, in addition to determining its percentage of rated capacity. Initial conditions for the modified performance discharge test should be identical to those specified for a service test.

COL 16.0-2-H 3.8.3-2

It may consist of just two rates; for instance, the one minute rate for the battery or the largest current load of the duty cycle, followed by the test rate employed for the performance test, both of which envelope the duty cycle of the service test. Since the ampere-hours removed by a one minute discharge represents a very small portion of the battery capacity, the test rate can be changed to that for the performance test without compromising the results of the performance discharge test. The battery terminal voltage for the modified performance discharge test must remain above the minimum battery terminal voltage specified in the battery service test for the duration of time equal to that of the service test.]

COL 16.0-2-H1-A 3.8.3-4

The acceptance criteria for this Surveillance are consistent with IEEE-1188450 (Ref. 14) and IEEE-485 (Ref. 5). These references recommend that the battery be replaced if its capacity is below 80% of the manufacturer's rating. A capacity of 80% shows that the battery rate of deterioration is increasing, even if there is ample capacity to meet the load requirements. The battery is sized to meet the assumed duty cycle loads when the battery design capacity reaches this [80]% limit.

BASES

The Surveillance Frequency for this test is normally 2460 months. If the battery shows degradation, or if the battery has reached 85% of its expected life Surveillance Frequency is reduced to 12 months. and capacity is < 100% of the manufacturer's rating, the Surveillance Frequency is reduced to 12 months. However, if the battery shows no degradation but has reached 85% of its expected life, the Surveillance Frequency is only reduced to 24 months for batteries that retain capacity ≥ 100% of the manufacturer's rating. Degradation is indicated, according to IEEE-1188450 (Ref. 14), when the battery capacity drops by more than 10% relative to its capacity on the previous performance test or when it is 90% of the manufacturer's rating. All these Frequencies are consistent with the recommendations in IEEE-1188450 (Ref. 14).

REFERENCES

1. IEEE Standard 1188.

2. Chapter 8.

32. Chapter 6.

43. Chapter 15.

54. IEEE Standard 450.

5. IEEE Standard 485.